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Maintenance Peritoneal Dialysis in Children With Autosomal Recessive Polycystic Kidney Disease: A Comparative Cohort Study of the International Pediatric Peritoneal Dialysis Network Registry

To the Editor:

ARPKD is a rare disorder but an important cause of early-onset pediatric kidney failure.[1-3] PD has been recommended as the method of choice for initiating dialysis in infants and small children,[4-6] but there are concerns regarding the feasibility of maintenance PD in ARPKD patients with their massively enlarged kidneys.[2,7] Some centers perform uni- or bilateral nephrectomies of native ARPKD kidneys.[8]

To systematically evaluate maintenance PD characteristics, residual kidney function, and patient and PD technique survival in pediatric ARPKD patients, we compared data from the International Pediatric Peritoneal Dialysis Network (IPPN) registry from children with ARPKD (n = 79), CNS (n = 79), and CAKUT (n = 158; Tables 1 and S1). Groups were matched for age and time on dialysis (Fig S1). PD modalities included CAPD and APD (~80% of patients). Patients with highly individualized regimens were excluded from the analysis of PD prescription. Differences in PD prescription over observation time were examined by linear mixed regression models (Item S1; Table S2).

Overall peritoneal fill volumes of all PD modalities combined were ~15% lower in ARPKD patients (704 ± 24 [SEM] vs 841 ± 24 and 822 ± 20 mL/m^2/d for CNS and CAKUT, respectively). This tendency was confirmed in models accounting for PD modalities (Fig 1A; Table S3) or oligoanuria (Fig S2; Table S4). Among CAPD patients, those with ARPKD received significantly more cycles (Fig 1A). Among APD patients, number of cycles and time spent on cycler were similar in all groups. Due to lower fill volumes, ARPKD patients on APD achieved lower PD fluid turnover than CNS and CAKUT patients (Fig 1A). Lower PD fluid glucose concentrations were prescribed in ARPKD patients on APD, resulting in significantly lower peritoneal glucose exposure. Despite this, ARPKD patients on APD achieved similar ultrafiltration volumes and thus had a higher ultrafiltration per glucose exposure ratio (Fig 1A). It is tempting to speculate that portal hypertension may add nonosmotic ultrafiltration in ARPKD patients.

At the baseline visit, 35 ARPKD, 39 CNS, and 23 CAKUT patients were already anuric (Table 1). Urine output at baseline was highest in CAKUT patients and lowest in CNS

Table 1. Patient and PD Characteristics at Enrollment, Incidence of PD Complications

	ARPKD	CNS	CAKUT	*P* for ARPKD vs CNS	*P* for ARPKD vs CAKUT
Characteristics					
No. of patients	79	79	158		
Age at BL visit, y	2.42 [0.84-6.77]	2.40 [0.78-5.56]	2.42 [0.80-6.76]	0.8	0.9
Age at start of current PD, y	1.28 [0.08-4.45]	1.53 [0.49-4.44]	1.27 [0.08-4.31]	0.1	0.9
Age at start of first KRT,[a] y	0.58 [0.05-3.46]	1.50 [0.49-4.16]	1.08 [0.07-4.16]	0.02	0.3
PD duration at BL visit, mo	4.0 [0.9-16.2]	3.4 [1.0-12.5]	3.8 [1.1-14.8]	0.7	0.9
F/U time, mo	13.2 [5.6-25.3]	8.4 [3.3-17.8]	12.7 [4.7-24.1]	0.1	0.9
Male sex	37 (47%)	43 (54%)	124 (78.5%)	0.3	<0.001
Anthropometric data at BL visit					
Height, SDS	−2.69 ± 1.48	−2.38 ± 1.76	−2.86 ± 1.74	0.2	0.4
Body mass index, SDS	0.34 ± 1.64	−0.04 ± 1.55	−0.03 ± 1.41	0.1	0.08
Urine output at BL visit[b]					
Urine output, mL/m^2/d	145 [0-1,071]	37 [0-586]	848 [378-1,516]	0.07	<0.001
Pts with oligoanuria	35 (49%)	39 (56%)	23 (16.7%)	0.4	<0.001
PD modality at BL visit				0.3	0.9
CAPD	17 (22%)	15 (19%)	32 (20.3%)		
APD (NIPD)	40 (51%)	32 (41%)	80 (50.6%)		
APD (CCPD)	21 (27%)	29 (37%)	43 (27.2%)		
Other	1 (1%)	3 (4%)	3 (1.9%)		
PD fluids at BL visit				0.8	0.1
Acidic lactate	40 (51%)	38 (48%)	96 (60.8%)		
pH-neutral fluid	39 (49%)	41 (52%)	62 (39.2%)		
Complications During F/U[c]	n = 37	n = 38	n = 75		
Exit-site and tunnel infections					
Rate per patient-y of F/U[d]	0.06	0.15	0.23		
Pts with ≥1 infection	2 (5%)	5 (13%)	15 (20%)	0.2	0.04
Pts with >1 infection	1 (3%)	2 (5%)	5 (7%)	0.6	0.4
Peritonitis episodes					
Rate per patient-y of F/U[d]	0.48	0.66	0.56		
Pts with ≥1 episode	12 (32%)	11 (29%)	25 (33%)	0.7	0.9
Pts with >1 episode	4 (11%)	8 (21%)	14 (19%)	0.2	0.3
Access revisions					
Rate per patient-y of F/U[d]	0.27	0.09	0.23		
Pts with ≥1 revision	8 (22%)	3 (8%)	18 (24%)	0.09	0.8
Pts with >1 revision	4 (11%)	1 (3%)	3 (4%)	0.2	0.2

Note: Unless otherwise indicated, data are count (percent), median [interquartile range], or mean ± SD. *P* values are based on χ^2, Mann-Whitney *U*, or *t* tests.
Abbreviations: APD, automated peritoneal dialysis; BL, baseline; CAPD, continuous ambulatory peritoneal dialysis; CAKUT, congenital anomalies of the kidneys and urinary tract; CCPD, continuous cycling peritoneal dialysis (APD with daytime dwell[s]); CNS, congenital nephrotic syndrome; F/U, follow-up; KRT, kidney replacement therapy; NIPD, nocturnal intermittent peritoneal dialysis (APD without daytime dwell); PD, peritoneal dialysis; SD, standard deviation; SDS, standard deviation score.
[a]Age at earliest initiation of KRT and includes KRT before current PD; ARPKD, n = 78; CAKUT, n = 154.
[b]Available urine data at BL: ARPKD, n = 72; CNS, n = 70; CAKUT, n = 138; oligoanuria defined as urine output < 100 mL/m^2/d.
[c]Only includes pts followed up from start of PD, pts with first visit >3 mo after PD starting date excluded.
[d]Patient-years of F/U defined as sum of F/U years per pt; total patient-years of F/U: ARPKD, 48; CNS, 46; CAKUT, 95.

patients, and the latter showed more frequent and earlier onset of oligoanuria over the course of PD (Fig S3). Patients with and without oligoanuria differed in key PD parameters, though mostly independent of the renal diagnosis (Fig S2; Table S4).

In incident maintenance PD patients (Table S5), exit-site and tunnel infections were reported less frequently in ARPKD than CAKUT patients (0.06 vs 0.23 episodes/year), whereas peritonitis frequency did not differ (Table 1). The need for PD access revisions in ARPKD patients was higher than in CNS patients but similar to CAKUT patients (Table 1). There were no significant differences in hospitalizations (Table S6) or anthropometric or metabolic parameters (Table S7).

Death on dialysis was observed in 13 ARPKD, 13 CNS, and 8 CAKUT patients (Table S8) with cumulative survival rates after 4 years on PD of 78% in ARPKD, 73% in CNS, and 95% in CAKUT (Fig S4). Patient age and the CAKUT diagnosis were inversely correlated with mortality (Fig S4; Table S9). While mortality was generally higher in patients who commenced PD in the first year of life, survival in this age group did not differ between ARPKD and CNS (Table S10).

PD technique survival rate was ∼80% after 4 years, without differences between disease groups (Fig 1B;

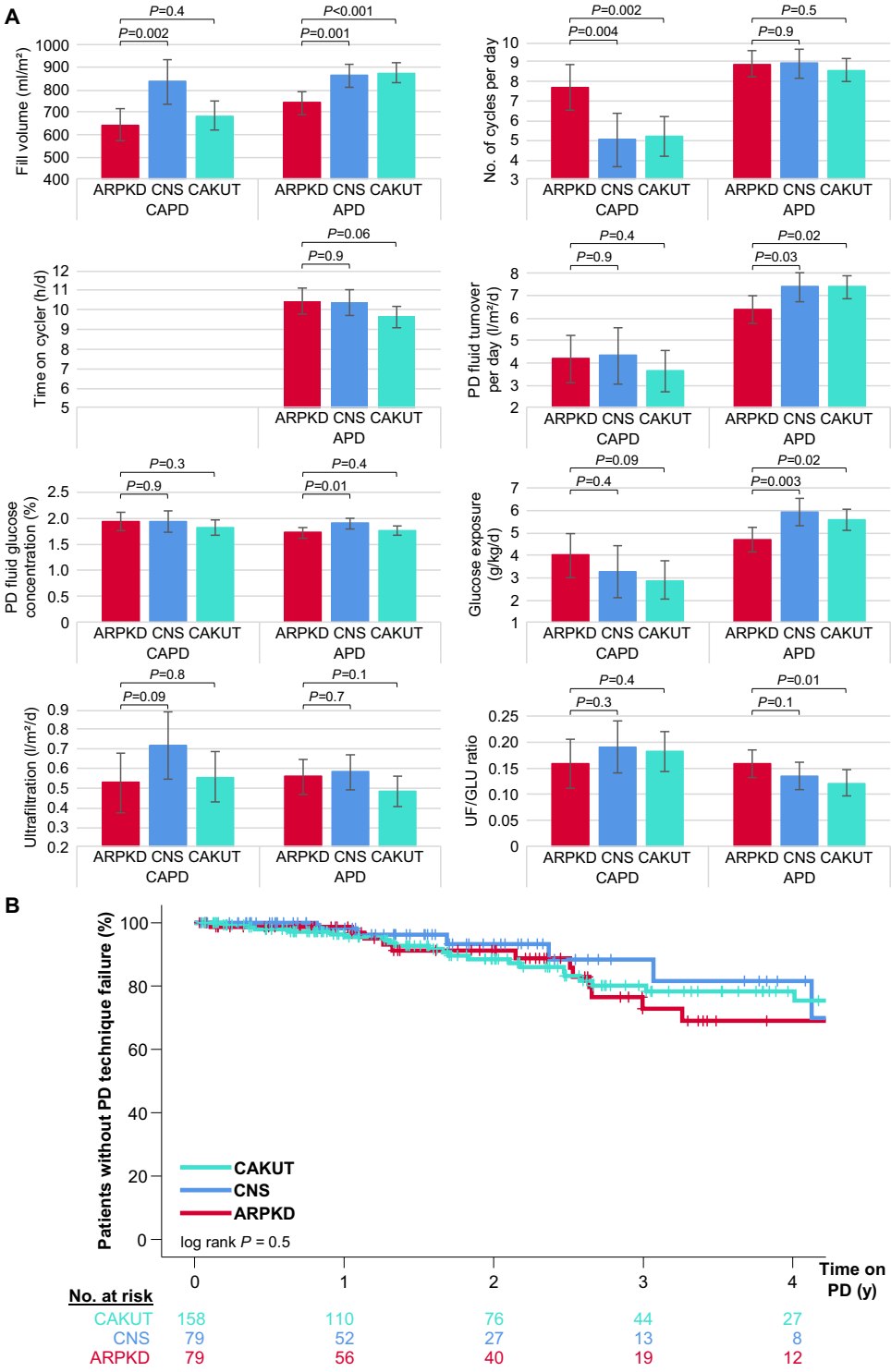

Figure 1. (A) PD prescription in patients. (B) Kaplan-Meier PD technique survival curves. (A) Data shown as model parameter estimates (mean and 95% confidence interval) and are based on linear mixed regression models (LMMs) for the entire observation time with an interaction term between diagnosis (ARPKD, CNS, CAKUT) and PD modality (CAPD, APD) (Total N: ARPKD, 72; CNS, 72; CAKUT, 144; Tables S2, S3); *P* values for CAPD are based on LMM with ARPKD/CAPD as reference group; *P* values for APD are based on LMM with ARPKD/APD as reference group. UF/GLU-ratio: ratio between ultrafiltration volume (L/m²/d) and glucose exposure (g/kg/d). (B) PD technique failure defined as switch to hemodialysis, death, or termination due to PD complications (infectious or noninfectious).

Table S11). Younger patients had higher risk for PD technique failure (Table S11).

Our study has some limitations. Because IPPN focuses on PD-related information, genotypes, hepatic involvement, gastrostomy tube insertion, vesicostomies, or nephrectomies were not systematically documented. Such data are currently collected in disease-specific cohort studies.[9,10] Because the median age at baseline was 2.4 years, we may have missed early-onset disease-specific aspects. Furthermore, reporting bias cannot be excluded due to the voluntary nature of the registry. Potential regional practice specificities cannot be sufficiently addressed.

In summary, maintenance PD can be performed successfully in children with ARPKD, with good patient survival and comparable technique outcomes as observed in other early-onset kidney diseases. Minor adaptations of PD prescription are usually required, probably to comply with the large kidney size. Remarkably, higher ultrafiltration per glucose ratios are achieved in children with ARPKD on APD, possibly related to portal hypertension.

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Supplementary Material

Supplementary File (PDF)

Figure S1-S4, Items S1-S2, Tables S1-S11.

Article Information

IPPN Registry: A list of the registry's principal investigators is provided in Item S2.

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